

Decomposition of Sodium Bicarbonate Stoichiometry Lab

OBJECTIVES

The purpose of this lab is to:

- Perform a decomposition reaction and measure the mass of the product(s) formed
- Using stoichiometry to determine which thermal decomposition reaction occurred during the experiment
- Calculate the percent yield and error for your experiment.

BACKGROUND

The word stoichiometry originates from the Greek words stoicheion; meaning element and metron; meaning measure. We use stoichiometry to describe the relationship between the relative quantities of substances taking part in a reaction or forming a compound, and are typically a ratio of whole integers. In this lab, you will use stoichiometry to probe the decomposition of sodium bicarbonate. Sodium bicarbonate may be more familiar to you as baking soda. Baking soda is very commonly listed as an ingredient in recipes for baked goods, pancakes and waffles. As the food item is being cooked or baked, the baking soda undergoes decomposition, releasing gas and causing the food item to “rise” and have a “light” texture. There are three theoretically possible chemical reactions that could occur during the thermal decomposition of baking soda.

- 1) sodium bicarbonate (s) $\rightarrow$ sodium hydroxide (s) + carbon dioxide (g)
- 2) sodium bicarbonate (s) $\rightarrow$ sodium oxide (s) + carbon dioxide (g) + water (g)
- 3) sodium bicarbonate (s) $\rightarrow$ sodium carbonate (s) + carbon dioxide (g) + water (g)

By comparing the theoretical yields of the possible solid products with the actual experimental yield of the product, you will be able to determine which of the above decomposition reactions occurred.

REQUIRED SUPPLIES

Sodium bicarbonate
Ceramic triangle
Crucible tongs

Bunsen Burner
Iron ring clamp

Crucible
Balance

PROCEDURE

- 1) Place a clean crucible on a ceramic triangle that is sitting on a iron ring clamp attached to a ring stand.
- 2) Using a Bunsen burner heat the crucible for 5 minutes on a low temperature and then allow to cool for approximately 10 minutes.
- 3) Bring your fingernail close to the crucible to determine if the crucible has cooled. Please note, that once the crucible has been heated, you cannot touch the crucible for the duration of the experiment with your fingers. The crucible is a porous material and will absorb the oils from your fingers skewing your experimental results.
- 4) Using crucible tongs, carry the crucible to the balance to get the mass of the cool crucible.
- 5) Add between 4-5g of sodium bicarbonate to the crucible and record the exact mass of the sodium bicarbonate being used.
- 6) Heat the crucible and sodium bicarbonate on a low flame for 2 minutes and then on a medium-high flame for 8-10 minutes.
- 7) After allowing the crucible to cool, take the mass of the crucible and product (s).
- 8) Repeat the heating of the crucible on a low flame followed by the medium-high flame again.
- 9) Once the crucible has again cooled take the mass of the crucible and product again. If the mass difference between the two heating cycles is greater than 0.1g, repeat the heating process again to ensure that the thermal decomposition has been completed and all of the gas products have been driven off.
- 10) Once the mass of product and crucible remain constant, discard the solid product as directed by your instructor, wash and dry the crucible and return all equipment to their initial location.

PRELAB QUESTIONS

- 1) Write balanced chemical reactions for all three theoretical decomposition reactions

- 2) 4.2g of sodium bicarbonate is equivalent to how many moles of sodium bicarbonate?

- 3) Using the number of moles calculated in question 2, how many moles and grams (theoretical yield) of solid product can be produced in each of the possible decomposition reactions?

- 4) Using decomposition reaction #1 and the theoretical yield calculated above, what would the percent yield be if the experimental yield was 1.85g?

- 5) What would be the percent error for decomposition reaction #1?

DATA

- A) Mass of empty and clean crucible _____g
- B) Mass of the crucible and sodium bicarbonate _____g

C) Mass of sodium bicarbonate used in the experiment (B-A) _____g

D) Moles of sodium bicarbonate used in the experiment _____g

E) Mass of crucible and decomposition product after the first heating _____g

F) Mass of crucible and decomposition product after the second heating _____g

G) Mass of crucible and decomposition product after third heating (if required)
_____g

H) Mass of decomposition product (E or F – A) _____g

DATA ANALYSIS AND POSTLAB QUESTIONS

1) Using the moles of sodium bicarbonate actually used in the experiment, calculate the theoretical yield of products from each of the possible decomposition reaction.

2) Which theoretical yield agrees with the experimental yield?

3) Which balanced chemical reaction actually occurred during this experiment?

4) What is the percent yield?

5) What is the percent error associated with the experiment?

REFERENCES

- 1) Adapted from “AccelLab19--DecompBakingSodaStoich” from
http://www.gobookee.org/get_book.php?u=aHR0cDovL3Bocy5wcnMuazEyLm5qLnVzL2pnaWFtbWFuY28vQWNjZWxDaGVtL0xhYnMvQTE5TGFiLURlY29tcEJha2VTb2RhLnBkZgpMYWlglYAxOTogRGVjb21wb3NpdGlubiBvZiBCYWtpbmcgU29kYSBTdG9pY2hpb21ldHJ5IC4uLg==
- 2) Adapted from “Baking soda stoich lab,” Dr. Breinan